RCMOS – Multidisciplinary Scientific Journal The Knowledge.
ISSN: 2675-9128. São Paulo-SP.

Year VI, v. 2026 | Submission: April 5, 2026 | Accepted: April 7, 2026 | Publication: April 9, 2026

Landscape Modifications: Social and Climatic Impacts

Landscape Modifications: Social and Climatic Impacts

Henrique Reis – Federal University of Minas Gerais, henriquefr96@gmail.com

Ana Demarques – Federal University of Minas Gerais, anademarques@gmail.com

Maria Muzzi – Federal University of Minas Gerais, mritascottimuzzi@gmail.com

Eleonora Sad – Federal University of Minas Gerais, eleonorasad@yahoo.com.br

Summary

Anthropogenic modifications to the natural landscape, driven by accelerated urbanization and industrialization processes, have exacerbated the climate crisis and generated critical socio-environmental vulnerabilities in urban centers. This work analyzes the relationship between urban densification and microclimatic impacts, focusing on the Confisco neighborhood in Belo Horizonte, identified as one of the areas most susceptible to heat waves, landslides, and food insecurity by 2030. The objective is to evaluate the feasibility of implementing green roofs as a nature-based solution to mitigate climate extremes and promote food security through urban gardens. The methodology consisted of a systematic literature review based on the PRISMA guidelines, selecting 33 highly relevant technical sources from databases such as *SciELO* and *Scopus.* The results indicate that green infrastructure regulates urban thermodynamics by redirecting solar radiation to latent heat flux, reducing surface temperatures by up to 10.46°C and retaining up to 90% of stormwater runoff. Socially, the integration of urban agriculture on rooftops strengthens the psychosocial resilience and food sovereignty of low-income families. It is concluded that, despite the economic and structural barriers to implementation, the transition to green infrastructure is imperative for climate justice and the viability of urban life.

Keywords: Climate Change. Green Infrastructure. Green Roofs. Socio-environmental Vulnerability.

Abstract

Anthropogenic changes to the natural landscape, driven by accelerated urbanization and industrialization processes, have worsened the climate crisis and generated critical socio-environmental vulnerabilities in urban centers. This work analyzes the relationship between urban densification and microclimatic impacts, focusing on the Confisco neighborhood in Belo Horizonte, identified as one of the areas most susceptible to heatwaves, landslides, and food insecurity by the year 2030. The objective is to evaluate the feasibility of implementing green roofs as a nature-based solution to mitigate climate extremes and promote food security through urban gardens. The methodology consisted of a systematic literature review based on PRISMA guidelines, selecting 33 sources of high technical relevance from databases such as SciELO and Scopus. The results indicate that green infrastructure regulates urban thermodynamics by redirecting solar radiation to latent heat flux, reducing surface temperatures by up to 10.46°C and retaining up to 90% of stormwater runoff.

Socially, the integration of urban agriculture on rooftops strengthens psychosocial resilience and food sovereignty for low-income families. It is concluded that, despite economic and structural barriers to implementation, the transition to green infrastructures is an imperative for climate justice and the viability of urban life

Keywords: Climate Change. Green Infrastructure. Green Roofs. Socio-environmental Vulnerability.

1. Introduction

Landscape is a complex term and is treated in different ways by various fields of study.

knowledge; in geography, it can be characterized by its concern with a certain group of

Year VI, v. 2026 | Submission: April 5, 2026 | Accepted: April 7, 2026 | Publication: April 9, 2026

phenomena that she attempts to identify and order according to their relationships (Sauer, 1925). Souza (2013) presents the divergences of the landscape as "landscape ecology" and as "research socio-spatial", the first one being seen through the lens of natural scientists and engineers only as synonymous with geographic space or area, and the second seen by geography as a concept of observation of space from an observer's point of view, where there are concerns about proximity and distance, between body and mind, and between observation and immersion.

A landscape can be defined as "natural" when it involves materials from the Earth's crust. and the shapes of the surface, which can be modified by climatic actions while its characteristics They develop through the action of time (Sauer, 1925). Another definition of landscape is the "cultural" one. that whose characteristics are defined by human actions and modifications to the environment; it is a The landscape is shaped by human-made marks on the site, and modified by the way humans have influenced it. how it uses the land, how it produces its food, how it organizes itself and how it builds its cities (Sauer, 1925).

With the technological revolutions brought about by the Industrial Revolution starting in the 19th century... In the 18th century, humans have been modifying the natural landscape without considering the finite nature of natural resources. of planet Earth (Feenberg, 2010) and generating irreversible climatic consequences according to IPCC AR6 report (Pörtner *et al.,* 2022). Climate change resulting from modifications Human-induced changes in the landscape have created an urban-environmental problem. The physical and natural characteristics The landscape places the population in situations of climate vulnerability that must be addressed. advocated in public policy agendas to mitigate extreme socio-environmental effects to which the The urban population is subjected to (Garcia *et al.,* 2023).

To create guidelines for mitigating climate vulnerabilities caused by human activity. In modifying the natural landscape, the Municipality of Belo Horizonte (PBH) commissioned an analysis of vulnerable areas in the city. Taking into account the existing social and environmental problems in these areas vulnerable populations in Belo Horizonte, this work aims to propose guidelines that can to benefit both the local climate and the population living in vulnerable areas.

2. Methodology

Aiming to analyze the relationships between landscape changes and climate problems and In social contexts, this work seeks to provide a theoretical foundation for the concepts that connect the cultural landscape. and the problems of urbanization. Given this, the aim is to present guidelines that can, at the same time... time to mitigate climate and social problems that are caused by anthropogenic modifications. in the urban landscape. To ensure scientific rigor and transparency in reporting the evidence, it adopted- if the PRISMA methodology (Preferred Reporting Items for Systematic Reviews and Meta-Analyses), which provides updated guidelines for identifying, selecting and synthesizing relevant studies (Page *et al.*

Year VI, v. 2026 | Submission: April 5, 2026 | Accepted: April 7, 2026 | Publication: April 9, 2026

al., 2022; Moher *et* al., 2015).

The research was based on an exhaustive search of databases.
of high academic relevance, including the SciELO, Scopus, Google Scholar platforms and the
CAPES Periodicals Portal. The use of these sources allowed for the mapping of concepts and
benefits of green infrastructure in the global and Brazilian context, aiding in the understanding of
dynamics of nature-based solutions (Richter *et* al., 2022; Zinia and McShane, 2018). The use of
Structured methodological protocols are essential for providing robust syntheses of the state of...
knowledge in a specific scientific field (Shamseer *et al.,* 2015; Page *et al.,* 2022).

During the literature review process, 43 sources were initially selected.
which addressed the interactions between urban densification, paving over, and environmental risks. After
the screening stage and the application of eligibility criteria prioritized relevant articles.
Regarding the technique of microclimatic and social performance, 33 sources were effectively used in the body.
of the work. The flow of information, from initial identification to final inclusion, followed the model
flowchart proposed by the PRISMA recommendation, ensuring the reproducibility of the study.
(Moher *et al.,* 2015; Page *et al.,* 2022).

The ultimate goal of this systematic review is to provide a solid scientific basis that
To assist in evidence-based decision-making for sustainable urban planning.
integration of data on the influence of vegetation on surface temperature and risk of
Floods allow us to correlate the technical performance of strategies with the urgent need.
of climate justice (Diener *et al.,* 2025; Garcia *et al.,* 2023). Thus, the review acts as support for
the development of guidelines to address urban aridity and promote food security.
in vulnerable settlements (IPCC, 2019; Richter *et al.,* 2022)

3. Urbanization and landscape modification

According to Todt *et al.* (2019), the first two industrial revolutions enabled the planet
to witness major changes throughout the 19th and 20th centuries, where industrialization allowed
It has significantly improved people's lives and, over time, has also exposed the costs.
social aspects of this economic advancement, where capitalism maintained its growth while others
They witnessed the poverty and the consequences of the exploitation of natural resources.

The rapid urbanization of planet Earth has brought about major changes in land cover, which
are directly linked to urban climate change, altering the energy balance of
Cities, decreasing evapotranspiration and altering the microclimate with heat islands in areas.
very dense (Omar, et al., 2018).

Monte-Mór (1994) introduces the concept of "Extensive Urbanization" where industrial capitalism
He takes over the city and controls its entire area of influence, causing the city to break apart and...

RCMOS – Multidisciplinary Scientific Journal The Knowledge.
ISSN: 2675-9128. São Paulo-SP.

Year VI, v. 2026 | Submission: April 5, 2026 | Accepted: April 7, 2026 | Publication: April 9, 2026

Its expansion beyond the urban fabric, forming what are known as metropolitan regions.

Extensive urbanization, which has been observed in Brazil since the 1970s, has modified the forms of

Imports created large urban and metropolitan areas throughout the country, as well as large peripheral areas.

concentration of people and social inequality.

This urban expansion of cities was marked by the occupation of floodplains and the sealing of soil.

from the ground, channeling waterways while ignoring the natural characteristics of the terrain and its dynamics.

of river basins, being the causes of environmental disasters of uncontrollable floods (Diener

et al., 2025).

Just like other major cities in the country, Belo Horizonte witnessed the

Extensive urbanization in its rapid growth during the 20th century. Planned as early as the 19th century.

According to Aarão Reis, the city was planned to be occupied within the limits of the "Avenida do Contorno" (Contour Avenue).

At its inauguration in 1897, it had only about 700 houses, but it experienced a construction *boom .*

Civilian during the government of Juscelino Kubitschek when it had 300,000 inhabitants and 40,000

buildings in the 1940s (Aragão, 2008). With the explosion of urban conurbation during the

Throughout the 20th century, Belo Horizonte continued to grow, reaching a population of approximately 2,315,560 inhabitants.

in 2022 (Brazil, 2022) and approximately 740,000 buildings (Prodabel, 2023).

4. The Landscape and the Climate

Climate is one of the main links in the natural landscape within a system, being the conditions

climatic conditions are responsible for shaping the soil, drainage, and surface characteristics (Sauer,

(1925). However, the urban climate is a substantial modification of the local climate caused by

built-up density (Monteiro, 1976).

The link between climate and landscape has become the key to geographical morphology in the physical sense.

(Sauer, 1925) and the climatic differences between countryside and city gained strength with the perception

due to the differences between the two areas. The city modifies the climate through alterations to the surface,

It produces more heat, creates changes in ventilation with its urban fabric, and creates differences in

Humidity, precipitation, and air pollution are the main problems.

climatology of modern and industrialized cities (Monteiro, 1976; Omar *et al.,* 2018).

As a result of increasing urbanization, it has been observed that dense metropolitan areas obtain

Significant increases in maximum temperature due to soil impermeability and pavements.

which heat the environment, resulting in the emergence of heat islands and an increased risk of

Floods (Diener *et al.,* 2025). Such pluvial floods occur when surface runoff

exceeds infiltration rates, manifesting itself in torrential rainfall events (Diener *et al.,* 2025).

The city faces severe climate problems, including heat islands exacerbated by...

changes in land cover (Razzaghmanesh *et al.,* 2016; Watrin *et al.,* 2020). Through this

RCMOS – Multidisciplinary Scientific Journal The Knowledge.
ISSN: 2675-9128. São Paulo-SP.

Year VI, v. 2026 | Submission: April 5, 2026 | Accepted: April 7, 2026 | Publication: April 9, 2026

overview, treat urban climate as a component of environmental quality, and implement actions

Nature-based mitigation measures become essential for quality of life (Omar *et al.,* 2018).

Vulnerability reports show that Belo Horizonte stands out with its structural programs of

Mapping risk areas in villages and favelas (Garcia *et al.,* 2023).

5. Study location - Confisco neighborhood - Belo Horizonte / MG

5.1 The Neighborhood

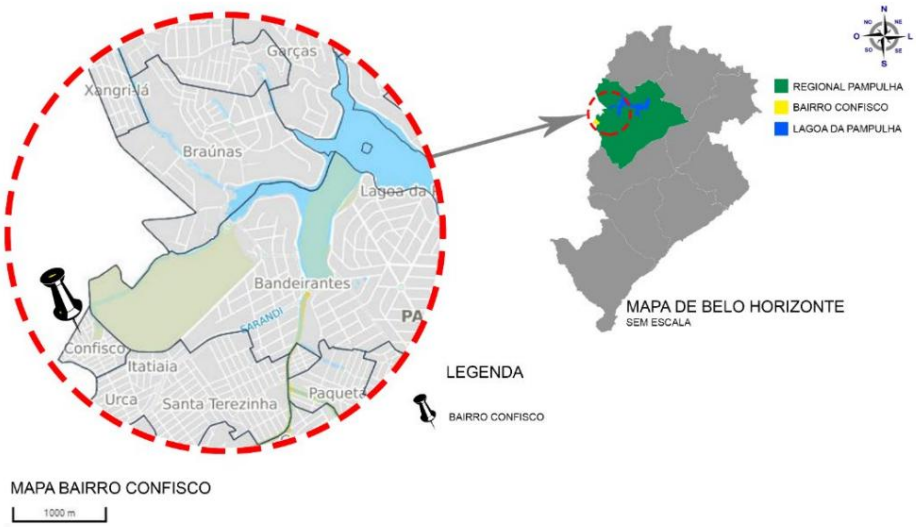
The Confisco neighborhood is located in the Pampulha region of Belo Horizonte/MG, and borders...

with the city of Contagem. According to the 2010 demographic census, the neighborhood had 4,283 inhabitants.

and 1217 dwellings in 2010 (Brazil, 2010). Currently the number of inhabitants reaches 7669 (Favela).

That's it, 2022).

Figure 01: Confisco Neighborhood Map



Source: Prepared by the author (2026), based on data from Prodabel and PBH (2023).

The Confisco neighborhood was established in 1988; the land was owned by Luciano Farah.

Initially, sixty families from various parts of the city who wanted housing occupied the

The space is being used while waiting for the Belo Horizonte City Hall to provide materials so they can begin construction.

from the houses. Later, another hundred families arrived from the camp of

Conjunto Mariquinhas, which occupied the remaining areas, the highest and most rugged parts of the neighborhood.

(That's what the favela is like, 2022).

The first dwellings in the neighborhood were makeshift, made of tarpaulins, and the living conditions were poor.

They were insufficient; there was a lack of water, electricity, sewage systems, transportation, and paved roads. According to

According to residents, the neighborhood has suffered from landslides since the last century (Favela é isso aí, 2022). In

In search of improvements for the region, the first residents' association was created in 1993.

to represent the interests of the community, earning the title of "Pro-Improvement Association"

from the Confisco Complex" (Favela is like that, 2022).

RCMOS – Multidisciplinary Scientific Journal The Knowledge.
ISSN: 2675-9128. São Paulo-SP.

Year VI, v. 2026 | Submission: April 5, 2026 | Accepted: April 7, 2026 | Publication: April 9, 2026

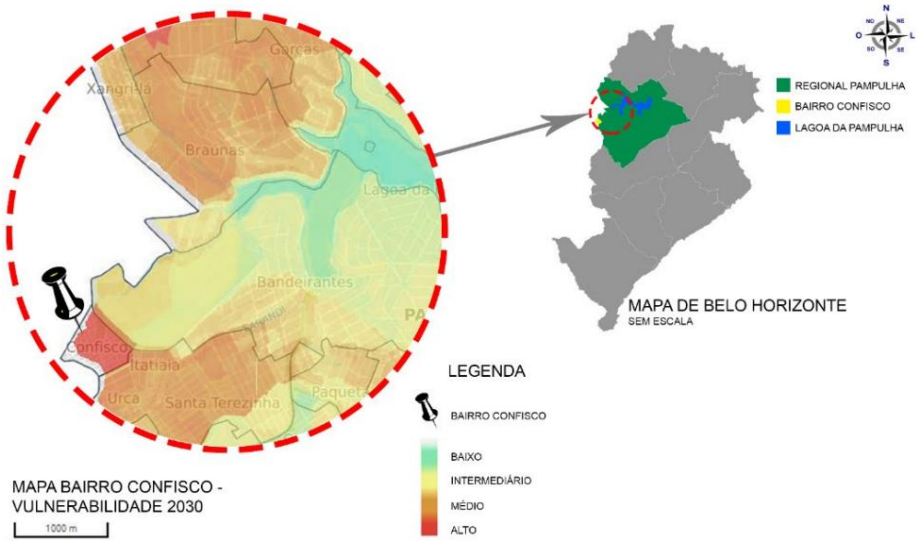
5.2 Vulnerabilities

Aiming to create guidelines to mitigate extreme weather events, the municipality of Belo Horizonte Horizonte (PBH) contracted, through the company “Way Carbon”, an analysis report of Vulnerability to climate change in the municipality in 2016, predicting scenarios for the year 2030. This report shows why the city has stood out for over 30 years with a "Structural Risk Area Program" that continuously maps, monitors, and intervenes in... consolidation and removal in areas at risk of geological hazards and flooding in villages and favelas (Garcia *et al.,* 2023).

The Confisco neighborhood was considered to have a high vulnerability index for dengue fever by 2030. Landslides and heat waves were observed, and the risk of flooding was considered intermediate. Given this... This observed scenario demonstrates the urgent need for interventions that help to mitigate the local climate effects, so that the population of Confisco does not suffer from the forecasts. climatic factors that are proving critical in the region (Follador *et al.,* 2016).

In light of the report on areas susceptible to vulnerability in Belo Horizonte presented Based on data from PBH (Follador *et al.,* 2016), it is possible to conclude that the Confisco neighborhood is one of the one of the most vulnerable areas of the city, being among the 10 most critical regions to suffer from the effects. Extreme weather events are expected by the year 2030.

Figure 2: Map of the Confisco neighborhood: Vulnerability 2030



Source: Prepared by the author (2026), based on Follador *et al.* (2016) and Prodabel/PBH.

6. Green Roof

In the 1970s, the urban environmental movement that began in Germany helped to occupy the Rooftops as a way to bring greenery back to cities. Several factors are driving the use of vegetation. on the slabs: urban planning, with cost and scarcity of land, soil impermeability and the Urban heat islands, reducing energy consumption in buildings, and the lack of green spaces in

RCMOS – Multidisciplinary Scientific Journal The Knowledge.
ISSN: 2675-9128. São Paulo-SP.
Year VI, v. 2026 | Submission: April 5, 2026 | Accepted: April 7, 2026 | Publication: April 9, 2026
urban infrastructure (Nascimento and Schmid, 2008).

For the implementation of a green roof, it is necessary to install a specific structure on the roof of the house. If the roof is simply a slab, it needs to be waterproofed; if it is made To replace ceramic roof tiles, it is necessary to remove them and install plywood sheets that will serve as a base for vegetation cover (Silva, 2011). In its simplest design, green roofs consist of a an insulation layer, a waterproofing membrane, a growing medium layer, and a layer of vegetation. This basic green roof design has been implemented and studied in several regions and climates around the world (Oberndorfer *et al.,* 2007).

6.1 Climatic Function

The green roof acts as a highly effective passive thermal regulator, mitigating the The phenomenon of urban heat islands is caused by an increase in the rate of evapotranspiration and... Redirecting solar radiation into latent heat flow. In tropical climates, this technology demonstrates the ability to reduce the surface temperature of roofs by more than 10°C, which It directly contributes to lowering the temperature of the surrounding air and to thermal comfort. inside buildings (Watrin *et al.,* 2020; Razzaghmanesh *et al.,* 2016).

In addition to the thermal benefit, vegetated systems play a crucial role in management. Urban water resources, functioning as a low-impact development (LID) tool. They They are able to retain between 50% and 90% of the volume of rainwater during precipitation events. delaying peak flow and reducing the overload on conventional drainage systems. This Water retention capacity is fundamental to mitigating the risks of rainwater flooding and landslides in areas with rugged topography and impermeable soil (Shafique *et al.,* 2018; Watrin *et al.,* 2020; Diener *et al.,* 2025).

Finally, vegetation on rooftops helps improve environmental quality by absorbing It helps to remove air pollutants and fix CO2, combating land degradation and biodiversity loss. in dense urban centers. By replacing dark, low-reflectivity surfaces with coverings With vegetation, the urban albedo increases, which helps to neutralize global warming on a large scale. local and to protect the waterproofing membranes against degradation by UV rays (Shafique *et al.,* 2018; Oberndorfer *et al.,* 2007; IPCC, 2019).

6.2 Social Function

Integrating urban gardens into green roofs represents a vital strategy for... promoting food sovereignty and nutritional security, especially in settlements vulnerable. Growing fruits and vegetables directly on rooftops allows the Families will have access to fresh, pesticide-free food, reducing their dependence on... long supply chains and reducing household food expenses (Richter *et al.,* 2022;

Year VI, v. 2026 | Submission: April 5, 2026 | Accepted: April 7, 2026 | Publication: April 9, 2026

Chowdhury *et al.,* 2020).

From a public health perspective, community and individual rooftop gardens
They strengthen the psychosocial resilience of residents by promoting engagement in "communities of
"Practice" and therapeutic contact with nature. Collective participation in the management of these spaces.
Green practices promote social cohesion, the exchange of traditional knowledge, and the environmental awareness of behaviors.
transforming the garden space into a place for environmental education and the exercise of citizenship.
(Carvalho *et al.,* 2021; Richter *et al.,* 2022).

The social function also extends to aesthetic appreciation and the creation of leisure spaces in
areas where available land is scarce or unsuitable for parks. The presence of vegetation improves
It improves the visual well-being of the community and can act as a buffer against urban noise, enhancing the...
The overall quality of life for residents. Thus, green roofs cease to be just a solution.
engineering technique to become an instrument of social justice and inclusive climate adaptation
(Zinia and McShane, 2018; Shafique *et al.,* 2018).

6.3 Implementation Challenges Despite the
numerous benefits, the widespread adoption of green roofs faces barriers.
Severe economic challenges exist, with the high initial cost being the main obstacle. It is estimated that the installation of
Vegetated systems can cost between 150 and 200 euros per square meter, which makes the technology...
inaccessible to low-income populations without the support of public subsidy policies or
tax incentives (Hrechko, 2022; Shafique *et* al., 2018).

Technically, implementation requires a rigorous diagnosis of the load capacity of the
buildings, since the water-saturated substrate adds significant weight to the structure.
original. In many cases, especially in informal settlements with precarious self-construction,
The need for structural reinforcement can make the project unfeasible or drastically increase costs.
requiring innovative and lightweight design solutions to ensure the safety of residents (Shafique *et*
al., 2018; Hrechko, 2022).

Additionally, maintenance issues and the risk of leaks are concerns.
Constant factors that generate cultural resistance to technology. Failures in the execution of waterproofing or
Inadequate selection of root barriers can lead to infiltration and structural pathologies.
serious, requiring specialized labor, continuous monitoring. Without a legislative basis.
Clear and comprehensive technical training programs for the community, the risk of infrastructure abandonment.
greens becomes elevated (Hrechko, 2022; Shafique *et* al., 2018; Nascimento and Schmid, 2008)

7. Results and Discussion

The results of this systematic review show that extensive green roofs are
effective in mitigating extreme weather events, reducing the surface temperature of roofs in

Year VI, v. 2026 | Submission: April 5, 2026 | Accepted: April 7, 2026 | Publication: April 9, 2026

up to 10.46°C in tropical environments (Watrin *et al.,* 2020). In the Confisco neighborhood, where the reports of Vulnerabilities indicate a high risk of heat waves and landslides; the application of these solutions Based on nature, it could drastically reduce local thermal and hydrological stress (Follador). *et al.,* 2016; Garcia *et al.,* 2023). The technical discussion reveals that water retention greater than 75% It qualifies the vegetated system as a vital hygrometric regulator for informal settlements. protecting buildings and mitigating floods (Watrin *et al.,* 2020; Fonseca *et al.,* 2025).

However, the discussion suggests that the social effectiveness of technology depends on overcoming the "Financial abyss" identified, given that installation costs are still prohibitive for low-income residents (Hrechko, 2022; Shafique *et al.,* 2018). There is also attention drawn to the risk of Climate gentrification, in which the environmental appreciation of the neighborhood could displace residents. original Confisco data for new risk areas (Richter *et al.,* 2022). In summary, the data converge for the need for urban planning that integrates rooftop food production with Legal security of land tenure, transforming green infrastructure into a community asset. permanent solution for addressing the environmental crisis (Chowdhury *et al.,* 2020; Carvalho *et al.,* 2021).

Final Considerations

It is concluded that anthropogenic modifications to the landscape, driven by urbanization, are the main causes of this change. Accelerated and waterproofing measures have exacerbated the climate crisis and social vulnerability in areas. peripheral areas like the Confisco neighborhood. The study demonstrated that the implementation of green roofs integrated into urban agriculture, it represents more than just a technical solution for thermal insulation and Water is not just a tool for psychosocial resilience and food sovereignty. However, for that to happen, For this solution to be viable in contexts of precarious housing, it is imperative to overcome the barriers. cost and structural challenges through inclusive public policies and technical support specialized. The transition to green infrastructure, guided by climate justice, is the way forward. fundamental to guaranteeing human dignity and urban survival in today's cities.

References

ARAGÃO, S. *Longing for BH.* Belo Horizonte: Editora Plêiade, 2008.

BRAZIL. Brazilian Institute of Geography and Statistics. *2010 Census.* Rio de Janeiro: IBGE, 2010.

Brazil. Brazilian Institute of Geography and Statistics. *2022 Census .* 2022.

CARVALHO, ICM Landscape, historicity and environment: the various natures of nature. *Confluenze: Rivista di Studi Iberoamericani,* v. 1, no. 1, p. 136-157, 2009.

CARVALHO, ICM; SCHMITT, LA; PEREIRA, MV. Education and sustainability: learning in an urban garden. *SIPS – Pedagogía Social: Revista Interuniversitaria,* v. 37, p. 173-183, 2021.

Year VI, v. 2026 | Submission: April 5, 2026 | Accepted: April 7, 2026 | Publication: April 9, 2026

CHOWDHURY, M. et al. Rooftop gardening to improve food security in Dhaka city: a review of the present practices. *International Multidisciplinary Research Journal,* vol. 10, 2020.

DIENER, KCZ; AGOSTINETTO, L.; SIEGLOCK, AE. Interaction between urban densification, waterproofing, soil change and flood risk. *Journal of Management and Secretarial Studies,* v. 16, n. 6, p. 1-32, 2025.

That's what a favela is all about. *Confisco Complex.* 2026.

FEENBERG, A. *The Critical Theory of Technology.* Planaltina: UnB, 2010.

FOLLADOR, M. et al. *Vulnerability analysis to climate change in the municipality of Belo Horizonte.* Belo Horizonte: PBH, 2016.

FONSECA, MT et al. Impact assessment and rehabilitation of an informal settlement using sustainable urban drainage systems as a nature-based solution in Brazil. *Environmental Development,* 2025.

GARCIA, LR; VIANA, JHM; LIMA, C. Risk management, environmental vulnerability and the climate issue in metropolitan management. *Brazilian Journal of Urban Management,* v. 15, 2023.

HRECHKO, AA. Experience and advantages of using green roofs as a green infrastructure element. *Bulletin of the National University of Kharkiv: Ecology,* v. 26, p. 32-42, 2022.

IPCC. *Climate change and land: IPCC special report.* Cambridge: Cambridge University Press, 2019.

MONTEIRO, CAF. *Theory and urban climate.* São Paulo: Institute of Geography – USP, 1976.

MONTE-MÓR, R. Extensive urbanization and settlement logics: an environmental perspective. In: SANTOS, M. et al. (org.). *Territory, globalization and fragmentation.* São Paulo: Hucitec, 1994.

MOHER, D. et al. Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015: elaboration and explanation. *BMJ,* vol. 349, 2015.

NASCIMENTO, W.; SCHMID, A. From the modern *gardens* to the current green roofs: can a hit become classic? In: *Conference on Passive and Low Energy Architecture.* Dublin, 2008.

OBERNDORFER, E. et al. Green roofs as urban ecosystems: ecological structures, functions and services. *BioScience,* vol. 57, no. 10, p. 823-833, 2007.

OMAR, A. et al. Green roof: simulation of energy balance components in Recife, Pernambuco State, Brazil. *Agricultural Engineering,* v. 38, no. 3, p. 334-342, 2018.

PAGE, MJ et al. The PRISMA 2020 statement: updated guidance for reporting systematic reviews. *Revista Panamericana de Salud Pública,* v. 46, 2022.

PÖRTNER, HO et al. *Climate change 2022: impacts, adaptation and vulnerability.* Cambridge: Cambridge University Press, 2022.

PRODABEL. *Buildings.* 2026.

Year VI, v. 2026 | Submission: April 5, 2026 | Accepted: April 7, 2026 | Publication: April 9, 2026

RAZZAGHMANESH, M.; BEECHAM, S.; SALEMI, T. The role of green roofs in mitigating urban heat island effects. *Urban Forestry & Urban Greening,* v. 15, p. 89-102, 2016.

RICHTER, MF et al. Urban gardens – history, classification, benefits and perspectives. *Confins,* n. 55, 2022.

SAUER, CO. The morphology of the landscape. In: CORRÊA, RL; ROSENDAHL, Z. (org.). *Landscape, time and culture.* Rio de Janeiro: EDUERJ, 1998.

SHAFIQUE, M. et al. Green roof benefits, opportunities and challenges: a review. *Renewable and Sustainable Energy Reviews,* vol. 90, p. 757-773, 2018.

SHAMSEER, L. et al. Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015: elaboration and explanation. *BMJ,* vol. 350, 2015.

SILVA, N. *Green roof: a more efficient construction system with less environmental impact.* 2011. Monograph (Specialization) – Federal University of Minas Gerais, Belo Horizonte, 2011.

SOUZA, ML *The fundamental concepts of socio-spatial research.* Rio de Janeiro: Bertrand Brasil, 2013.

TODT, M.; BERG, OA; FRÖHLICH, M. Ecological agenda and the global south: growth, environmental justice and ecological debt. *Conversations & Controversies,* v. 6, n. 1, 2019.

WATRIN, VR et al. Thermal and hydrological performance of extensive green roofs in Amazon climate, Brazil. *Engineering Sustainability,* vol. 173, no. 3, p. 125-134, 2020.

ZINIA, NJ; MCSHANE, P. Ecosystem services management: evaluation of green adaptations for urban development. *Landscape and Urban Planning,* vol. 173, p. 23-32, 2018.